PACKER TESTS

Packer tests consist of isolating specific sections (usually 10 ft) of a bedrock borehole with inflatable packers (bladders) so that water-quality samples can be collected and aquifer tests can be conducted. A series of such tests allows definition of the vertical distribution of water quality (usually contaminants) and hydraulic conductivity (pathways for water and contaminant movement) in an aquifer. Monitoring water levels in nearby wells while pumping packed intervals can identify permeable intervals within the aquifer. Information from the packer tests can be used to properly site the future location of monitoring wells.

Smaller packers designed to fit a submersible sampling pump can be used isolate the lower part of a monitoring well. Isolation by the packer allows reduced water volumes to be purged prior to sampling. This reduction can be beneficial because it can reduce purge times and may limit the handling and disposal of contaminated water.

Why Do Packer Tests?

- Give vertical distribution of hydraulic properties and water quality in the aquifer
- Usually cheaper than a nest of wells and gives more continuous record

Cautions:

- Water-quality data should be considered reconnaissance data. (Packers may leak, well may not be full developed, with removal of all contaminants and water introduced during and after drilling)
- May provide open conduit for contaminant movement to depth within an aquifer if left open after drilling without a temporary packer

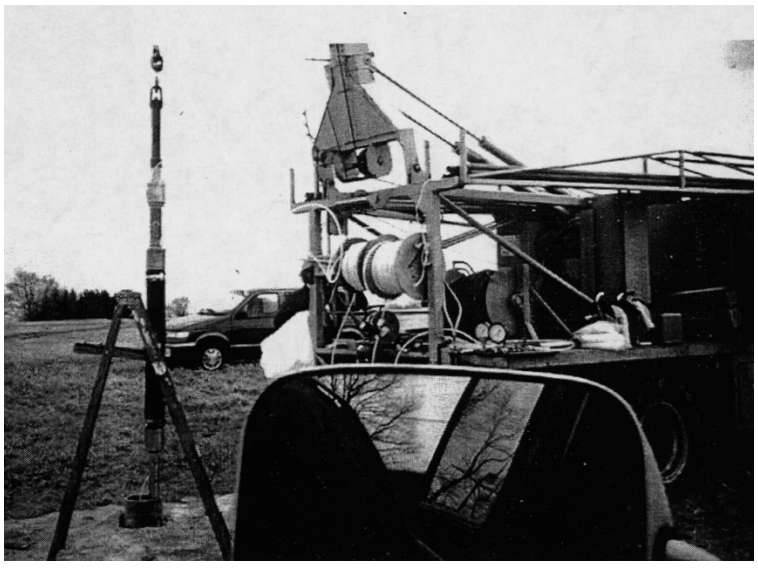
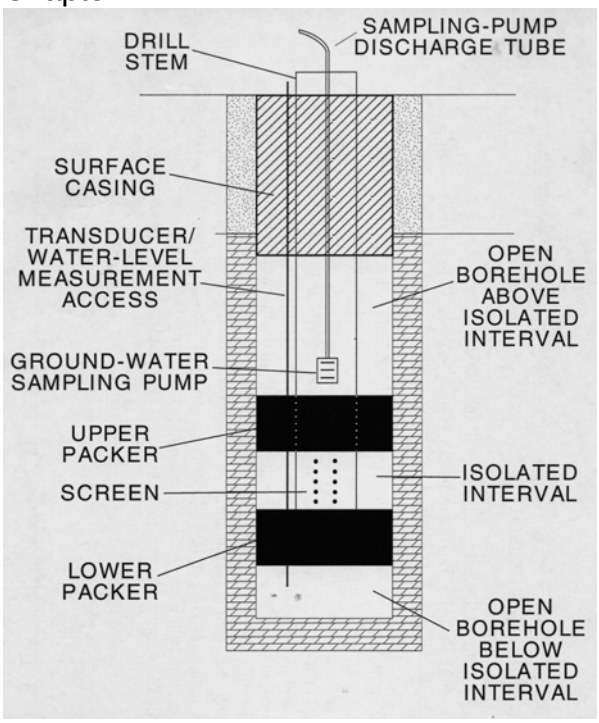


Figure – Packer-hoisting rig and straddle-packer system (upper blabber and screen shown lowered in borehole)



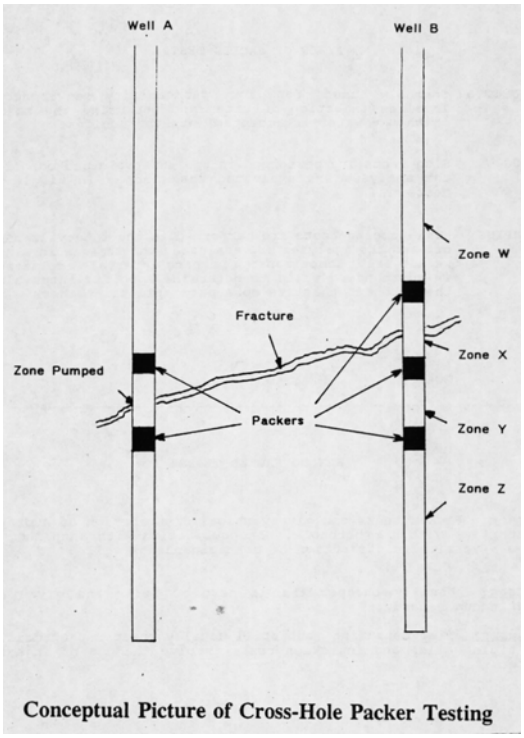


Figure – Schematic of straddle-packer system in A borehole

METHODOLOGY

- Develop entire length of borehole to ensure test intervals don't contain water and fines from drilling
- Decontaminate packer equipment before use
- Lower to test zone and inflate packer(s)
- Monitor pressures and water levels to ensure equilibration of pressures in test intervals and leakage between intervals

[((DTP-DTW) * FT H20 To PSI Conversion Factor) + Packer Inflation at Atmospheric Pressure] * Fudge 1.3

- Purge at 1-2 gal/min; Remove 3 well volumes and monitor field parameter stability
- Pump at 0.25-0.5 gal/min to limit uptake of fine sediment, aeration, volatilization
- Place pump intake above the level that would allow dewatering of the test interval
- Monitor pump rate and water level

Water level very important. May affect analyte chemistry and packer position if drawdown is too great during purging and sampling

USEFUL RESOURCES: (Bolded ones stress or discuss field techniques)

- **Heath, R.C., 1984, Basic Ground-Water Hydrology, U.S. Geology Water-Supply Paper 2220, 84 p.**
- Bear, Jacob, 1979, Hydraulics of groundwater: McGraw-Hill, New York, 569 p.
- Davis, S.N. and DeWeist,R.J.M., 1966, Hydrogeology: John Wiley & Sons, New York, 461 p.
- **Driscoll, F.G., 1987, Groundwater and wells: Johnson Division, St. Paul, Minnesota, 1089 p.**
- **Fetter. C.W.,1988, Applied hydrogeology, Merrill Publishing Co.: Columbus, Ohio, 592 p.**
- Freeze, R.A. and Cherry, J.A., 1979, Groundwater: Prentice-Hall, Inc., Englewood Cliffs, N.J., 604 p.
- **Kruseman, G.P. and de Ridder, N.A., 1991, Analysis and evaluation of pumping test data: International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, pub. 47, 377 p.**
- Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality: Selection and installation of wells, and supporting documentation: U.S. Geological Survey Water-Resources Investigations Report 96-4233, 110 p.
- **Nielson, D.M. (ed.), 1991, Practical handbook of ground-water monitoring: Lewis Publishers, Inc., Chelsea, Mi., 717 p.**
- Todd, D.K., 1980, Groundwater hydrology: John Wiley & Sons, New York, 535 p.
- **U.S. Geological Survey Technical Water-Resources Investigations Reports**
- **American Society for Testing and Materials guidelines**

Photographs of data-collection equipment from promotional materials prepared by: Bennett Sample Pumps, Inc., Campbell Scientific, Inc., In-Situ, Inc., HydroTechnics, Inc.,

References cited or used in compilation of course notes:

Alley, W.M., ed., 1993, Regional ground-water quality: New York, Van Nostrand Reinhold, 634 p.

Brehana, J.V., 1998, Field hydrology—theory, techniques, and applications, unpublished summer field course workbook: U.S. Geological Survey and University of Arkansas, [variously paged]

Bouwer, H. and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells: Water Resources Research, v. 12, no. 4, p. 423-428.

Driscoll, F.G., 1987, Groundwater and wells: St. Paul, Min., Johnson Division, 1089 p.

Fetter, C.W.,1993, Contaminant hydrogeology: New York, Mcmillan, 458 p.

Heath, R.C., 1983, Basic ground-water hydrology: U.S. Geological Survey Water-Supply Paper 2220, 84 p.

Keys, W. S. and MacCary, L.M., 1990, Application of borehole geophysics to water-resources investigations: U.S. Geological Survey Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 2, chapter E1, 126 p.

Koterba, M.T., Wilde, F.D., and Lapham, W.W., 1995, ground-water data-collection protocols and procedures for the national water-quality assessment program: collection and documentation of water-quality samples and related data: U.S. Geological Survey Open-File Report 95-399, 113 p.

Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality: selection and installation of wells, and supporting documentation: U.S. Geological Survey Water-Resources Investigations Report 96-4233, 110 p.

Lohman, S.W., 1979, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.

Mills, P.C., Yeskis, D.J., and Straub, T.D., 1998, Geologic, hydrologic, and water-quality data from selected boreholes and wells in and near Belvidere, Illinois, 1989-1996: U.S. Geological Survey Open-File Report 97-242, 151 p.

Nielson, D. M., ed., 1991, Practical handbook of ground-water monitoring: Chelsea, Mi., Lewis, 717 p.

Paillet, F.L. and Williams, J.H., eds., 1994, Proceedings of the U.S. Geological Survey workshop on the applications of borehole geophysics to ground-water investigations, Albany, New York, June 2-4, 1992: U.S. Geological Survey Water-Resources Investigations Report 94-4103, 79 p.

Reilly, T.E., Franke, O.L., Buxton, H.T., Bennett, G.D., 1987, A conceptual framework for ground-water solute-transport studies with emphasis on physical mechanisms of solute transport: U.S. Geological Survey Water-Resources Investigation Report 87-4191, 44 p.

Reynolds, S.D., 1991, Selection and analysis of shallow aquifer tests, notebook for short course no. 1, 34th annual meeting, September 29-October 5, 1991, Chicago, Ill.: Association of Engineering Geologists, [variously paged]

Stallman, R.W., 1968, Aquifer-test design, observation, and data analysis: U.S. Geological Survey Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 3, chapter B1, 26 p.

U.S. Department of Energy, 1997, In situ permeable flow sensor: U.S. Department of Energy Innovative Technology Summary Report, April 1997, 16 p.

U.S. Environmental Protection Agency, 1990, Ground water, volume 1: ground water and contamination: U.S. Environmental Protection Agency Handbook, EPA/625/R-93/003a, [variously paged]

U.S. Environmental Protection Agency, 1991, Site characterization for subsurface remediation: U.S. Environmental Protection Agency Seminar Publication EPA/625/4-91/026, 259 p.

U.S. Environmental Protection Agency, 1992, Aquifer-test and interpretation workshop, unpublished notes for workshop presented June 15-19, 1992, Willowbrook, Ill., [variously paged]

U.S. Environmental Protection Agency, 1993, Subsurface characterization and monitoring techniques, a desk reference guide, volume 1: solids and ground water, appendixes A and B: U.S. Environmental Protection Agency Technology Transfer EPA/625/6-90/016a, 144 p.

U.S. Geological Survey, 1998, Introduction to borehole geophysics: accessed March 4, 1998 at URL http://wwwdnyalb.er.usgs.gov/projects/bgag/intro.text.html

U.S. Geological Survey, 1999, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, [variously paged]

Welch, A.H., 1995, Field water-quality methods for ground water and surface water, unpublished notes for a training class presented October 16-27, 1995, Lakewood, Col.: U.S. Geological Survey, [variously paged]

Yeskis, D., Chiu, K., Meyers, S., Weiss, J., and Bloom, T., 1988, A field study of various sampling devices and their effects on volatile organic contaminants, *in* Proceedings of the Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring, and Geophysical Methods, Las Vegas, 1988: Dublin, Ohio, National Water Well Association, p. 471-479.

Yeskis, D.J., ed., 1995, Waste site characterization, unpublished notes for workshop presented November 6-9, 1995, Siauliai, Lithuania: U.S. Environmental Protection Agency, Chicago, Ill., [variously paged]

Zohdy, A. A. R., Eaton, G.P., and Mabey, D.R., 1990, Application of surface geophysics to ground-water investigations: U.S. Geological Survey Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 2, chapter D1, 116 p.